ABSTRACT OF THE DISCLOSURE

The present invention provides a method and system to simultaneously use the microwave and Zeeman end resonances associated with the same sublevel of maximum (or minimum) azimuthal quantum number *m* to lock both the atomic clock frequency and the magnetic field to definite values. This eliminates the concern about the field dependence of the end-resonance frequency. In an embodiment of the system of the present invention, alkali metal vapor is pumped with circularly-polarized D_1 laser light that is intensity-modulated at appropriate resonance frequencies, thereby providing coherent population trapping (CPT) resonances. In another embodiment, pumping with constant-intensity circularly-polarized D_1 laser light enhances magnetic resonances that are excited by alternating magnetic fields oscillating at appropriate resonance frequencies. In both embodiments, the resonances are greatly enhanced by concentrating most of the atoms in the initial state of the resonances, and by diminishing the spin-exchange broadening of the resonances. This leads to greater stability of optically pumped atomic clocks. This invention can also be used to operate an atomic magnetometer, where the feedback signal used to stabilize the magnetic field at the alkali-vapor cell can serve as a sensitive measure of the ambient magnetic field.